18. (Twice Amended) A plasma enhanced chemical vapor deposition of diamond crystals and diamond films on surfaces of a substrate comprising:

providing an apparatus including an inlet, a disassociation zone, a deposition zone and an outlet;

introducing, in the absence of a gas stream, a liquid precursor substantially free of water and comprising methanol and at least one carbon containing compound containing a carbon to oxygen ratio greater than one into the inlet under conditions effective to vaporize the liquid precursor, flow the vaporized precursor through the disassociation zone, and through the outlet;

disassociating and reacting the vaporized precursor as vaporized precursor flows or diffuses through the disassociation zone to produce OH, H, O, and carbon containing radicals; and

transporting the carboncontaining radicals to the substrate in the deposition zone to produce the diamond crystals or diamond films on the surface of the substrate.

REMARKS

Applicant respectfully requests reconsideration of the above application. Upon entry of the amendment herein, claims 1, 3, and 5-18 remain pending in the instant application.

Objections

The specification has been objected to for containing a trademark. The specification has been amended herein to include the generic terminology, polytetrafluorothethylene, to accompany the trademark, TEFLON. Consequently, Applicant respectfully requests withdrawal of this basis of objection.

Rejection of claims 1, 3, 5-7, and 9-12 under 35 U.S.C. §103(a)

Claims 1,3, 5-7, and 9-12 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Japanese Patent No. JP 05-247651 to Idemitsu ("Idemitsu") in view of U.S. Patent No. 5,874,014 to Robson et al. ("Robson"). Applicant respectfully urges that this basis of rejection is made moot by the amendment of claim 1 herein.

As amended herein, claim 1 includes introducing a liquid precursor that is substantially free of water into a reaction chamber in the absence of a gas stream. Such a method of forming diamond crystals or diamond films provides a more efficient and economical process than that taught or suggested by Idemitsu and Robson, either singly or in combination. By providing a liquid precursor that contains essentially no water beyond that normally provided with the individual constituents of the precursor, the claimed invention reduces the likelihood of problems occurring due to water in the system. Conversely, the chance of water freezing at the precursor controller orifice or condensing on the reactor manifold appears to be significant with the levels of water found in the alcohol/water solutions disclosed or taught in Robson.

The claimed invention also avoids the safety and cost concerns that accompany the use of a gas stream to form diamond crystals or films. Gas streams containing hydrogen or other compressed gases, such as those found in each of the examples of Idemitsu and some of those of Robson, may be explosive or otherwise dangerous in the case of gas leakage from a high-pressure gas cylinder to the ambient. Thus, their use would necessitate implementation of significant safety precautions. In some locations, the presence or use of compressed or explosive gases further is prohibited, thereby precluding the forming of diamond crystals with such streams in those locations. Furthermore, their use would necessitate precision and expensive gas flow

controllers and liquid flow controllers in order to achieve reproducible and desirable composition of precursor mixtures that are critical for diamond deposition.

The invention as provided in amended claim 1 is patentable over the combination of Idemitsu and Robson and the other cited references. None of the references, singly or in combination, teach or suggest a precursor in the form of a liquid solution that is substantially free of water and containing methanol and at least one other carbon containing compound with a carbon to oxygen ratio greater than one and that is introduced into the reaction chamber in the absence of any gas additives or a gas stream. The precursors disclosed in the cited references either must be accompanied by a gas stream of a carrier gas or a gas additive, such as hydrogen and carbon dioxide, or include substantial amounts of water. Since claims 3,5-7 and 9-12 depend from claim 1 these claims are also patentable over the cited references. Consequently, Applicant respectfully requests withdrawal of this basis of rejection.

Rejection of claims 13-18 under 35 U.S.C. §103(a)

Claim 8 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Idemitsu in view of U.S. Patent No. 5,225,275 to Aida ("Aida"). Applicant respectfully urges that this rejection is made moot by the amendment herein of claim 13. Idemitsu and Aida both appear to disclose only precursors accompanied by gas streams. In contrast, claim 13, as amended, provides for introducing a liquid precursor into the apparatus in the absence of a gas stream. Consequently, the combination of Idemitsu and Aida does not teach nor suggest all the limitations set forth in claim 13. Furthermore, since claims 14-18 depend from claim 13, Applicant respectfully urges that in view of the foregoing, claims 14-18 are also not made

obvious by the combination of Idemitsu and Aida. Therefore, Applicant respectfully requests withdrawal of this basis of rejection.

CONCLUSION

Applicant respectfully urges that the present application is now in condition for allowance. Claims 1, 3, and 5-18 remain pending in the present application and are allowable as explained herein. If the Examiner believes that there are any unresolved issues, Applicant respectfully requests Examiner contact the undersigned Applicant's attorney.

Respectfully submitted,

3/4/02
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Appendix

IN THE SPECIFICATION

Please substitute the following paragraph for the paragraph beginning at line 10 of page 10 and ending at line 4 page 11 of the specification.

Figure 1 generally illustrates the plasma enhanced chemical vapor deposition system utilized in performing the method of the present invention. As illustrated in Fig. 1, the precursor 5 is fed from a precursor container 4 by a conduit 6, such as a TEFLON (polytetrafluoroethylene) or metal tubing, through a liquid flow controller 7, such as a needle valve, to an inlet 2 of reactor chamber 1. The reactor chamber 1 is formed from a material capable of withstanding the temperature generated during the CVD process. In the present invention, the reactor chamber 1 is stainless steel and typically 8" in diameter. When the liquid precursor 5 enters the low pressure side of the liquid flow controller 7, it vaporizes to form a vapor precursor 5 comprising a mixture with the same molar composition as the liquid precursor 5. In addition to inlet 2, the reactor chamber 1 has an outlet 3 connected to a mechanical vacuum pump 13 through an automatically controlled throttle valve 14 to maintain constant pressure in the reaction chamber 1 throughout the deposition process and for circulating the vapor of the precursor 5 through the reactor chamber 1. The vapor precursor 5 is maintained at a pressure within the vacuum chamber 1 of between 1 mtorr and 250 torr, with the pressure being monitored by a pressure gauge (not shown).

IN THE CLAIMS

Please amend claims 1, 11 and 13 as follows:

1. (Twice Amended) A method of forming diamond crystals or a diamond film comprising

disposing a substrate in a reaction chamber;

introducing, in the absence of a gas stream, a liquid precursor substantially free of water and containing methanol and at least one carbon containing compound having a carbon to oxygen ratio greater than one into an inlet of the reaction chamber;

vaporizing the liquid precursor; and

subjecting the vaporized precursor to a plasma under conditions effective to disassociate the vaporized precursor and promote diamond growth on the substrate.

11. (Twice Amended) The method according to claim 10, wherein the electromagnetic energy [has a frequency] is selected from the group consisting of direct current, radio [frequency] waves and [microwave] microwaves.

13. (Twice Amended) A plasma enhanced chemical vapor deposition of diamond crystals and diamond films on surfaces of a substrate comprising:

providing an apparatus including an inlet, a disassociation zone, a deposition zone and an outlet;

introducing, in the absence of a gas stream, a liquid precursor substantially free of water and comprising methanol and at least one carbon containing compound containing a carbon to oxygen ratio greater than one into the inlet under conditions effective to vaporize the liquid precursor, flow the vaporized precursor through the disassociation zone, and through the outlet;

disassociating and reacting the vaporized precursor as vaporized precursor flows or diffuses through the disassociation zone to produce OH, H, O, and carbon containing radicals; and

transporting the carbon containing radicals to the substrate in the deposition zone to produce the diamond crystals or diamond films on the surface of the substrate.